DOCUMENT RESUME

ED 409 196 SE 060 388

TITLE	Mathematics 33 Diploma Examination Results. Examiners' Report for January 1997.
INSTITUTION	Alberta Dept. of Education, Edmonton. Student Evaluation Branch.
PUB DATE	97
NOTE	9p.; For the Mathematics 33 Examination, see ED 407 275. Printed on colored paper.
AVAILABLE FROM	Alberta Dept. of Education, Student Evaluation Branch, 11160 Jasper Avenue, Edmonton, Alberta T5K 0L2, Canada.
PUB TYPE	Reports - Evaluative (142)
EDRS PRICE	MF01/PC01 Plus Postage.
DESCRIPTORS	Evaluation; Foreign Countries; High Schools; *Mathematics Achievement; *Mathematics Education; Standards; *Test Results
IDENTIFIERS	*Alberta

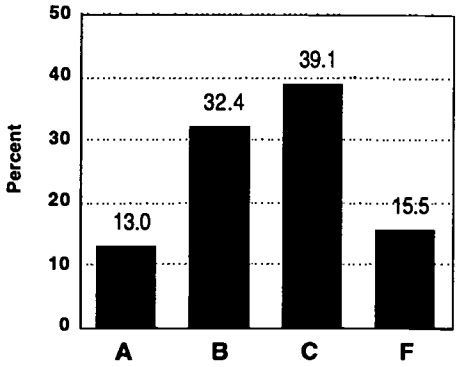
ABSTRACT

The summary information contained in this report provides teachers, school administrators, students, and the general public with an overview of results from the January 1997 administration of the Mathematics 33 Diploma Examination by the Alberta Department of Education in Canada. This information is most helpful when used with the detailed school and jurisdiction reports that have been provided to schools and school jurisdiction offices. Findings indicate that 86.8% of the 5,634 students who took the test achieved the acceptable standard and 13.1% of these students achieved the standard of excellence. Topics discussed include a description of the examination, achievement of standards, results and examiners' comments, multiple-choice and numerical-response questions, students' achievement of the curriculum standards in the units on trigonometry and polynomials/rational expressions, and written-response questions. (JRH)

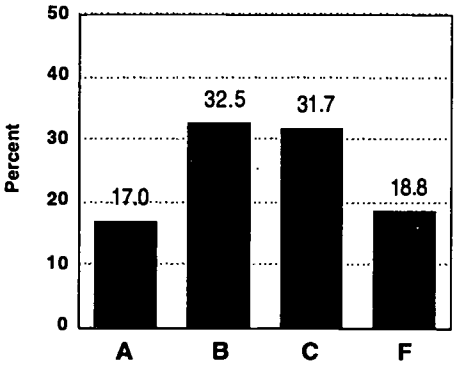
Mathematics 33

Diploma Examination Results
Examiners' Report for January 1997

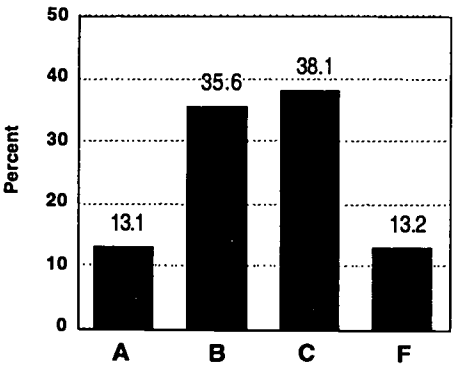
School-Awarded Mark



Diploma Examination Mark



Final Course Mark



The summary information in this report provides teachers, school administrators, students, and the general public with an overview of results from the January 1997 administration of the Mathematics 33 Diploma Examination. This information is most helpful when used with the detailed school and jurisdiction reports that have been provided to schools and school jurisdiction offices. A provincial report containing a detailed analysis of the combined January, June, and August, results is made available annually.

Description of the Examination

The Mathematics 33 Diploma Examination consists of 37 multiple-choice questions worth 53%, 12 numerical-response questions worth 17%, and 4 written-response questions worth 30% of the total examination mark.

Achievement of Standards

The information reported is based on the final course marks achieved by 5 634 students who wrote the January 1997 examination.

- 86.8% of the 5 634 students achieved the acceptable standard (a final course mark of 50% or higher).
- 13.1% of these students achieved the standard of excellence (a final course mark of 80% or higher).

Approximately 49.7% of the students who wrote the January 1997 examination were females.

- 87.8% of the female population achieved the acceptable standard (a final course mark of 50% or higher).
- 16.4% of these students achieved the standard of excellence (a final course mark of 80% or higher).

Approximately 50.3% of the students who wrote the January 1997 examination were males.

- 81.3% of the male population achieved the acceptable standard (a final course mark of 50% or higher).
- 9.6% of these students achieved the standard of excellence (a final course mark of 80% or higher).

Provincial Averages

- The average school-awarded mark was 62.4%.
- The average diploma examination mark was 63.6%.
- The average final course mark, representing an equal weighting of the school-awarded mark and the diploma examination mark, was 63.6%.

Of the 5 634 students who wrote the January 1997 examination, 415 had written at least one Mathematics 33 Diploma Examination previously.

Results and Examiners' Comments

This examination has a balance of question types and difficulties reflecting the philosophy of the Mathematics 33 Course of Studies. It was designed so that students who are achieving the acceptable standard in Mathematics 33 should obtain a mark of 50% or higher. Students who are achieving the standard of excellence in Mathematics 33 should obtain a mark of 80% or higher. The student who is achieving the acceptable standard or the standard of excellence is expected to be able to achieve the curriculum standards identified in the *Mathematics 33 Information Bulletin.* At least 80% of the examination includes questions and tasks that students who achieve the acceptable standard should be able to complete successfully. The remaining part of the examination includes questions and tasks that students who achieve the standard of excellence should be able to complete successfully.

Future examinations will continue to focus on assessing students' understanding of mathematical concepts and on problem solving. Students will continue to be expected to solve problems, explain solutions, justify solutions, and/or apply concepts and procedures in the written-response section. The design of examinations will include items that assess how well students have achieved the general learner expectations stated in the Mathematics 33 Course of Studies.

Blueprint

Question	Key	Difficulty	RF	Q	PR	RE	TR	ST	AML	Math Und.
MC 1	A	0.716		√						C
MC 2	B	0.728		√						P
MC 3	B	0.549	√							C
MC 4	B	0.601		√						P
NR 1	2.35	0.696	√							P
NR 2	61.7	0.491					√			P
WR 1	–	0.538					√			PCPS
MC 5	D	0.548				√				P
MC 6	D	0.503					√			C
MC 7	B	0.663		√						PS
MC 8	A	0.689		√						C
WR 2	–	0.704	√							PCPS
NR 3	3	0.831			√					P
MC 9	B	0.726			√					P
MC 10	D	0.920			√					P
MC 11	B	0.727			√					P
MC 12	D	0.615				√				C
MC 13	D	0.730				√				P
MC 14	B	0.759				√				P
NR 4	1.25	0.482				√				P
MC 15	A	0.773	√							P
MC 16	A	0.308	√							C
MC 17	D	0.936	√							C
MC 18	B	0.795	√							C
MC 19	A	0.647		√						C
MC 20	D	0.605		√						C
WR 3	–	0.503		√						PCPS
NR 5	10.3	0.719		√						P
MC 21	D	0.493		√						P
NR 6	0.93	0.232					√			P
MC 22	D	0.840		√						C
MC 23	C	0.576		√						PS
MC 24	C	0.791					√			PS

Question	Key	Difficulty	RF	Q	PR	RE	TR	ST	AML	Math Und.
NR 7	2304	0.555							√	P
MC 25	C	0.804	√							C
MC 26	D	0.730							√	C
MC 27	D	0.753							√	P
WR 4	–	0.662							√	PCPS
MC 28	D	0.591							√	C
NR 8	40	0.586						√		P
MC 29	C	0.680						√		C
MC 30	C	0.824						√		C
MC 31	A	0.482						√		P
MC 32	D	0.478								C
MC 33	B	0.759	√							P
NR 9	192	0.686					√			P
NR 10	290	0.728					√			PS
NR 11	132	0.310					√			PS
MC 34	C	0.600				√				PS
NR 12	70	0.806			√					PS
MC 35	C	0.698					√			PS
MC 36	B	0.410						√		P
MC 37	D	0.749	√							C

Subtests

When analyzing detailed results, bear in mind that subtest results **cannot** be directly compared. Some of the written-response questions involve concepts and problem solving procedures from more than one core content area.

Results are in average raw scores.

Machine scored: 31.9 out of 49

Written response: 12.5 out of 21

Course Emphasis on Machine-Scored Questions

RF	Relations and Functions	6.8 out of 10
Q	Quadratic Functions and Equations	7.3 out of 11
PR	Powers and Radicals	4 out of 5
RE	Polynomials and Rational Expressions	3.7 out of 6
TR	Trigonometry	4.4 out of 8
ST	Statistics	3 out of 5
AML	Annuities, Mortgages, and Loans	2.6 out of 4

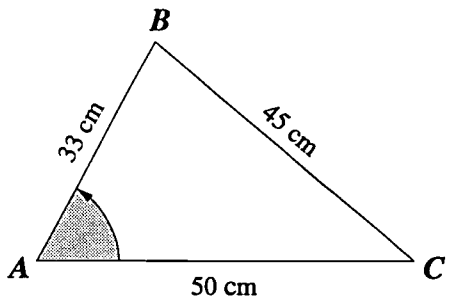
Mathematical Understandings* on Machine-Scored Questions

Procedural (P): 14.2 out of 22
Conceptual (C): 12.1 out of 18
Problem Solving (PS): 5.7 out of 9

*Refer to Appendix F of the 1996–97 *Mathematics 33 Information Bulletin, Diploma Examinations Program,* for an explanation of mathematical understandings.

Use the following information to answer the next question.

Lori also created plans for a triangular support. In drawing the side view of the support shown below, Lori needed to include measurements for the angles.



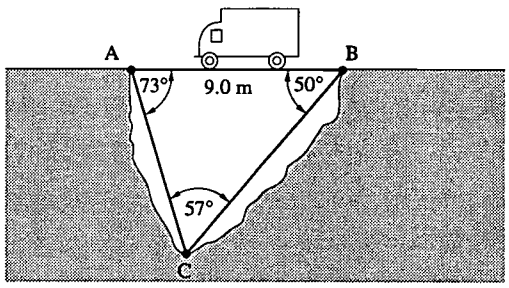
Numerical Response

2. The measure of angle A, to the nearest tenth of a degree, is _____.
(Record your answer on the answer sheet.)

Answer: **61.7**

Use the following information to answer the next question.

The span of a bridge to be constructed between points A and B is measured to be 9.0 m in a survey.



The surveyor noted that from point A, the angle of depression to point C is 73°, and from point B, the angle of depression to point C is 50°. In order to build the support system, the measures from point B to point C and from point C to point A needed to be determined.

24. The distance from point B to point C, to the nearest tenth, is

A. 6.9 m

B. 8.2 m

•C. 10.3 m

D. 12.2 m

Multiple-Choice and Numerical-Response Questions

Questions on the examination were grouped around scenarios or practical situations that occur in real life. The multiple-choice, numerical-response, and written-response questions were mixed within the scenarios of the examination, and where appropriate, questions from the same unit of the course were organized together. Teachers involved in the marking session stated that students responded very positively to the exam and that the format was friendly and appropriate. A discussion of how well students met the curriculum standards in the units Trigonometry and Polynomials/Rational Expressions follows.

Trigonometry — To achieve the curriculum standards for trigonometry, students should be able to solve problems that involve oblique and right triangles and problems that involve extensions of trigonometry to the coordinate plane. Multiple-choice questions 6 and 24 and numerical-response questions 2 and 6 are examples of questions embedded in the exam to ensure students achieve the standards. Numerical-response question 2 and multiple-choice question 24 involve practical applications of the cosine law and sine law, respectively. Approximately 49% of students who wrote the examination met the expectations for numerical-response question 2, as did 79% for multiple-choice question 24.

Numerical-response question 2 required students to determine, using the cosine law, an angle of an oblique triangle, and multiple-choice question 24 required students to find, using the sine law, a missing side of a triangle. Of the students who achieved the standard of excellence, 85.3% correctly answered question 24, as did 50.5% of students who achieved the acceptable standard but not the standard of excellence, and 11.6% of students not achieving the acceptable standard.

When required to solve an oblique triangle without a selection of answers, students' responses appear to contain more errors. Markers of the written-response questions indicated that some students were uncertain of when and where to apply the sine and cosine laws.

Multiple-choice question 6 and numerical-response questions 6 and 9 required students to solve trigonometric problems having extensions related to a coordinate plane. Markers were pleased to see a question related to the graph of a trigonometric function. About 50.3% of students answered this question correctly.

Students were less successful on numerical-response question 6, which tests a pure and deeper understanding of rotational angles on the coordinate plane than does numerical-response question 9, which is an application of rotational angles to the airline industry. Approximately 23.2% of students correctly answered numerical-response

Use the following information to answer the next question.

While studying electronics, Lori needed to check the effective resistance *(R)* in a circuit. Lori added the terms in the rational expression

$$\frac{5}{R}+\frac{2}{R-2}$$

5. A simplified form of $\frac{5}{R}+\frac{2}{R-2}$, where $R \neq 0$ or 2, is

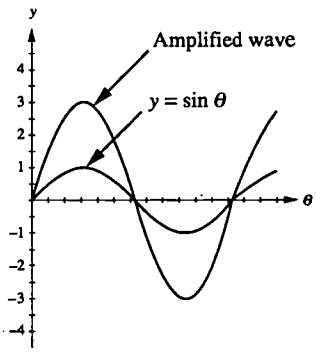
A. $\frac{5R-10}{R-2}$

B. $\frac{7}{2R-2}$

C. $\frac{7}{R(R-2)}$

•D. $\frac{7R-10}{R(R-2)}$

Use the following information to answer the next question.



Lori built a project that related mathematics to operating a radio station. Lori determined that an Amplified Modulation station (AM radio station) transmits a signal by changing the amplitude of the sine wave, as represented by the equation $y = \sin \theta$ and shown in the graph on the left.

6. The graph of the amplified wave above appears to be a representation of the equation

A. $y = \sin \theta - 3$

B. $y = \sin \theta + 3$

C. $y = \sin 3\theta$

•D. $y = 3 \sin \theta$

question 6; whereas 68.6% of students did so for numerical-response question 9. Of students who met the standard of excellence, 60.7% correctly answered numerical-response question 6, compared with 86.7% for numerical-response question 9. From the results, it appears that students are strong at determining rotational angles for practical situations but need to improve their abilities to determine trigonometric ratios for rotational angles.

Polynomials and Rational Expressions — To achieve the acceptable standard in polynomials and rational expressions, students must be able to extend operations on rational numbers to operations and applications of rational expressions. In the scenario "Connections," the operations on rational expressions were related to previous understandings such as factoring and operations on rational numbers. Students were successful in making connections and realizing the expectations of both single-step and multistep questions.

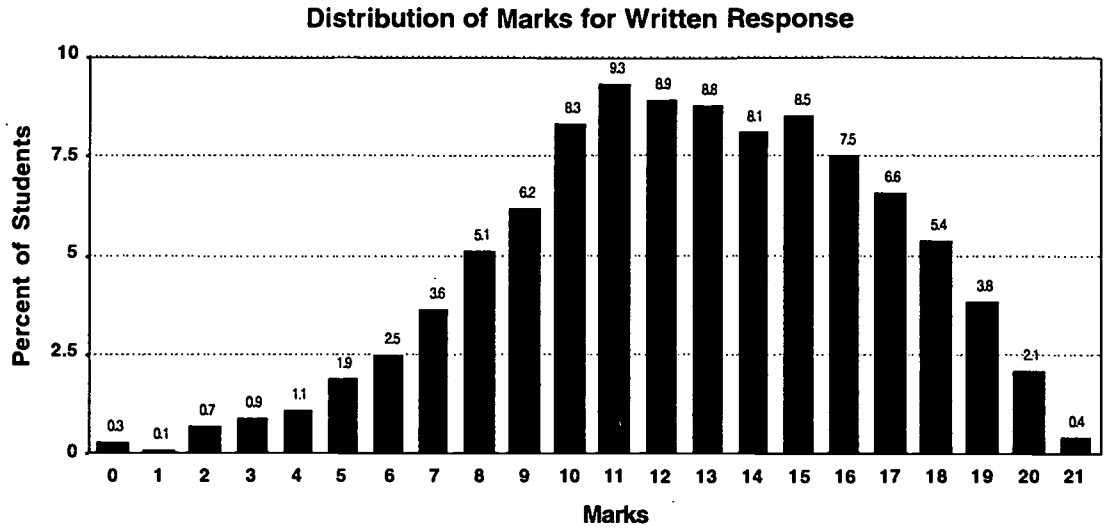
Multiple-choice question 12 asked students to apply factoring to finding non-permissible values. About 61.5% of students correctly answered this question. On this question, 90.0% of students who achieved the standard of excellence, 63.4% of those who achieved the acceptable standard but not the standard of excellence, and 29.1% of those who were not able to meet the acceptable standard answered correctly.

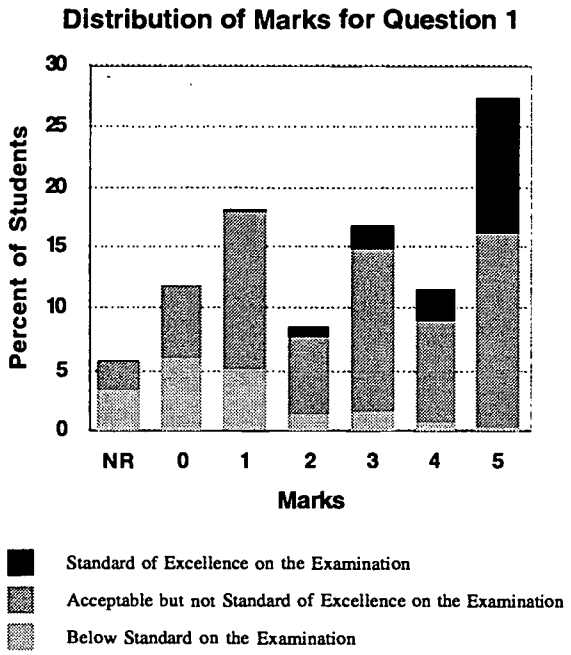
Multiple-choice questions 13 and 14 and multiple-choice question 34 test single and multiple conceptual and procedural understandings. Approximately 73%, 76%, and 60%, respectively, of students correctly answered these questions.

Multiple-choice questions 5 and 34 are practical applications of rational expressions. Multiple-choice question 5, an applied multistep question, required understanding of the operation of addition on rational expressions. About 54.8% of students answered this question correctly. Students appear to be better at answering questions that require multiple steps than in previous years. Of students meeting the standard of excellence, 88.1% were successful on this question, compared with only 20.6% of students not meeting the acceptable standard. Previous testing also suggested that students were not successful on multistep questions involving rational expressions that required factoring. For example, over the past two years, students were only successful on rational expression items presented in factored form. Current results suggest that students are now better able to answer questions in unfactored form and that involve multiple steps.

Written-Response Questions

The chart below shows the percentage of students achieving various marks on the written-response questions. The maximum mark obtainable was 21. Questions in the written-response section dealt with five of the seven content strands for Mathematics 33. Students achieving the acceptable standard were expected to obtain at least half of the possible marks on all questions. Students achieving the standard of excellence were expected to get almost full marks.





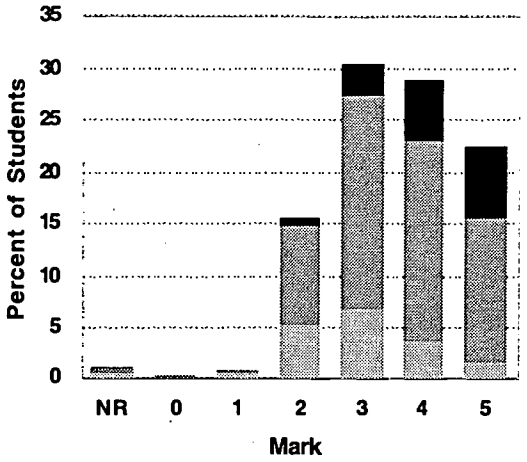
Question 1 required students to recognize right and oblique triangles and to apply appropriate trigonometric ratios and laws in determining the lengths of shelving brackets. This question was marked with a five-point holistic scale. Students who achieved the acceptable standard were expected to score at least 3 of 5 marks on this question and 68.4% of them achieved either 3, 4, or 5 marks on this question. Students at the standard of excellence were expected to communicate logical, clear, complete, and correct answers, with supporting detail, using proper mathematical syntax, and 82.4% of them achieved either 4 or 5 marks on this question.

On this 5-mark question, the average mark was 2.69 or 54%.

Overall, the responses impressed the markers. Of the all students answering this question, 33.3% presented solutions that met the standard of excellence.

The main strength of responses for question 1 was problem solving. Students used a variety of methods to solve this problem, many of which were innovative. Many responses demonstrated appropriate problem-solving techniques, where steps were clearly organized and presented in a neat fashion. Responses suggested that students read the question well, and communicated their answers well. Teachers marking this question expressed concern over the number of syntax, rounding, procedural, and communication errors.

Distribution of Marks for Question 2

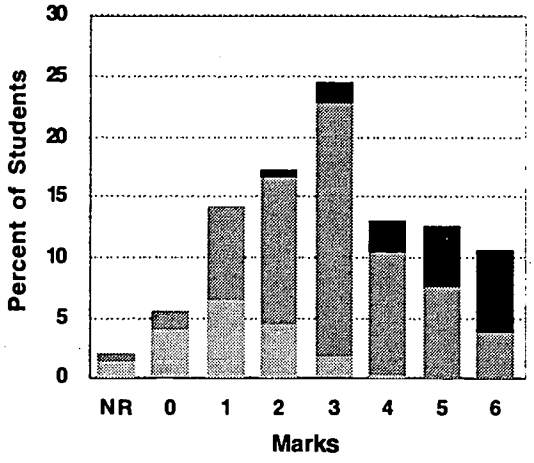


Standard of Excellence on the Examination

Acceptable but not Standard of Excellence on the Examination

Below Standard on the Examination

Distribution of Marks for Question 3



Standard of Excellence on the Examination

Acceptable but not Standard of Excellence on the Examination

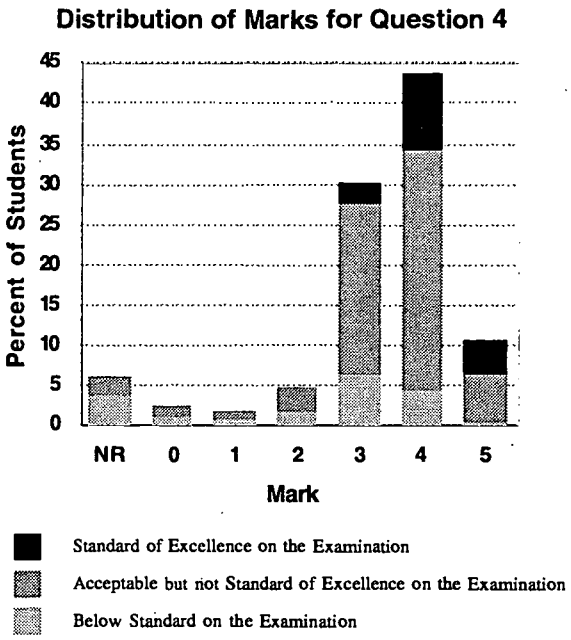
Below Standard on the Examination

Students commonly misused equal signs, e.g., "AB = cos $25° = \frac{30}{x} = 33.1$." In terms of rounding errors, students were either rounding values too soon or not rounding at all. Procedural errors commonly occurred as students set up correct basic trigonometric ratios such as $\cos 25° = \frac{30}{AB}$, but multiplied incorrectly ($30 \times \cos 25°$) to get an incorrect answer. Other procedural errors included using primary trigonometric ratios to solve oblique triangles or failing to distinguish right triangles from oblique triangles. The markers felt that not enough students laid out their work in an logical manner that clearly communicated the process they used to solve the problem. Some students used a correctly calculated value for the side of the triangle as part of their solution, but provided little or no supporting detail.

Question 2 required students to illustrate data from a table in the format of a graph and then provide analysis of real life data from either the context of the table of values or the graph that was provided. The question was scored using a holistic scoring criteria with a scale of five. It was expected that students achieving the acceptable standard but not the standard of excellence would score 3 of 5 marks on this question: 84.4% of them met or exceeded this expectation. Students achieving the standard of excellence were expected to provide clear, correct, and complete answers, with supporting detail and justification between data and concluding statements made, by students, and 76.3% met this expectation.

On this 5-mark question, the average mark was 3.52 or 70%.

Markers felt students handled the intended scope of the problem well. The majority of graphs that students made were done well, and student responses demonstrated good analytical skills. Although students only needed to focus on the mathematical content of the solution, many used their understandings of the relationship between temperature and pressure to provide reasons for changes in data, and thereby created impressive solutions beyond the mathematical realm. In most responses, the relationship between data and concluding statements were communicated well. Most students' responses included the intended scope of the problem. However, markers identified the weaknesses in some student responses as being attributable to poor communication and conceptual understanding. For example, students described graphs as being exponential or inverse, or incorrectly stated maximum or critical values in their explanations. Students must be careful to describe graphs accurately and focus on specifics, such as maximum values.



Question 3 required students to analyze other students' work, apply procedural understanding, and demonstrate understanding of the relationship between algebraic and graphical representations of a quadratic function, using clear and accurate communication.

This question was marked using an analytic guide with holistic subparts. Part a was scored out of 2 marks and parts b and c were combined and scored out of 4 marks, for a total of 6 marks. Students who achieved the acceptable standard were expected to score at least 3 of the 6 marks. Of these students, 72.8% received 3, 4, 5, or 6 marks on this question. Students who achieved the standard of excellence were expected to score 5 or 6 marks on this question and 70% achieved this expectation.

On this 6-mark question, the average mark was 3.02 or 50%.

The markers felt that the strengths of the responses included determining the vertex, demonstrating understanding of the effects of the parameter on graphs of $y = a(x - h)^2 + k$, and showing a variety of correct methods for determining x-intercepts. As well, markers were impressed with the number of students who attempted all parts of the question. Of the 5 634 students who wrote the examination, only 114 did not attempt any part of this question. Weaknesses identified by markers included demonstrating poor understanding of x- or y-intercepts, misusing mathematical terminology and syntax, and neglecting to include concluding statements. The misuse or absence of equal signs is an example of poor mathematical syntax or communication. To enhance grades, students need to write complete responses, clearly explain mathematical understandings, logically organize responses, and include proper mathematical syntax.

Question 4 required students to analyze a spreadsheet, recognize patterns, and determine various values related to the amortization of a loan. This question was marked on a five-point holistic scale. It was expected that students achieving the acceptable standard would score at least 3 of 5 marks on this question and 93.4% did so. Of the students who achieved the standard of excellence, 81.8% achieved either 4 or 5 marks.

On this 5-mark question, the average mark was 3.31 or 66%.

Teachers reported that students used many creative methods to solve the question, particularly in part b. Students demonstrated overall understanding of loans, strong organizational skills, good communication and numeracy skills. Weaknesses included poor attention to detail (such as forgetting to show calculations), providing unreasonable answers, and neglecting to include dollar signs. Many students would have enhanced their grades by paying attention to detail and providing complete solutions.

For further information, contact Ron Flaig (rflaig@edc.gov.ab.ca) or Phill Campbell (pcampbell@edc.gov.ab.ca) at the Student Evaluation Branch at 427-0010. To call toll-free from outside of Edmonton, dial 310-0000.

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